

Combining data science and medical imaging

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Summary

Radiomics, an emerging field where many others intersect- medical physics, biostatistics, and computational biology, finds its significant application in recent cancer research. Radiomics can extract a large amount of data from medical images, uncovering advanced features that characterize tumors non-invasively through data analysis. These features can robustly create a unique phenotypic atlas for each tumor. Associating clinical information to this atlas has enabled the identification of new, reproducible, image-based biomarkers, which have been used to predict tumor response to a specific treatment and understand tumor evolution or its intrinsic biology. Such tools will enable precision medicine in cancer treatment at an earlier time, providing crucial information to guide clinician decisions.

PART 1: PREDICTION OF LUNG TUMOR RESPONSE TO CHEMORADIATION

Currently, simple metrics such as tumor volume or diameter are used as surrogates for tumor response to treatment. These basics metrics were inadequate in predicting tumor response after chemoradiation. By using advances imaging features from pre-treatment images, we could identify tumors that are likely responsive to chemoradiation. Those results can develop into a crucial tool for clinicians and potentially be used routinely to improve standard of care and outcomes. Better treatment decisions will help reduce physical, emotional, and financial burden on patients; and on a larger scale, it will reduce cost on the healthcare system through avoiding unnecessary surgeries, complications, and medications.

PART 2: LUNG TUMOUR EVOLUTION AFTER RADIOTHERAPY TREATMENT

The ability to characterize tumors that will likely develop distant metastasis or local recurrence based on their imaging traits at an early time point, especially prior to any treatment, is an advancement in cancer care. Once patients develop metastasis or experience recurrence, the disease become significantly harder to treat and the chance of survival quickly diminishes. This research findings will help clinicians make better decisions in patient management- particularly closer follow up and/or increase in chemotherapy for patients at risk to improve outcomes. This work in lung cancer can also be leveraged in understanding other types of tumors that frequently metastasize.

PART 3: TUMOUR INTRINSIC NATURE ASSESSMENT

A cutting-edge method of extracting big data from positron-emission tomography (PET) and computed tomography (CT) images can provide additional information to quantify lung tumors caused by a genetic mutation. This information will help guide the most effective treatment by selecting the patient type that would most likely respond and experience good outcomes. This ability to differentiate will also help accelerate treatment for other patients that will not benefit from these mutation-specific medications. We also shown the potential of magnetic resonance images (MRI) to distinguish grade within meningioma patients. On a larger scale, this can contribute to reducing healthcare cost by improving diagnosis speed and accuracy, and as a result not paying for therapies that will not work for specific patients. This project also demonstrates the versatile application of radiomics in many different types of medical images, such as CT, PET, MRI, to better understand cancer.